EXHAUST SYSTEM

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention relates to an exhaust system that purifies exhaust gas using catalyst and converts thermal energy of the exhaust gas into electric energy.

2. Description of Related Art

Generally, an exhaust system includes an exhaust emission catalyst such as a three-way catalyst to purify exhaust gas discharged from an engine by removing hazardous substance contained in the exhaust gas, for example, carbon monoxide, hydrocarbon, nitrogen oxides and the like. The catalyst becomes effective to purify the exhaust gas when it is activated at its activated temperature in the range between 350°C and 800°C, for example.

Substantially high thermal energy of the exhaust gas at a high temperature is partially used for increasing the temperature of the exhaust emission catalyst until it reaches the activated temperature. The rest of the thermal energy of the exhaust gas, however, is dispersed without being collected. An exhaust heat power generation apparatus has been developed to collect the thermal energy through conversion thereof into electric energy.

In a certain type of the aforementioned exhaust heat power generation apparatus, a thermoelectric converting module is interposed between an exhaust pipe (high temperature side) through which the exhaust gas flows and a cooling unit (low temperature side), and each thermoelectric converting element of the thermoelectric converting module generates power in accordance with the temperature difference between the high temperature side and the low temperature side (Related Art 1: JP-A-10-234194). The temperature difference has to be increased while raising the temperature at the high temperature side so as to improve the thermoelectric conversion efficiency. In the other type of the exhaust heat power generation apparatus, the catalyst provided in an exhaust passage is used for purifying the exhaust gas as well as increasing the exhaust gas temperature (the temperature at the high temperature side of the thermoelectric converting module) under the reaction heat (Related Art 2: JP-A-2000-352313) .

Generally, in the exhaust system, when the catalytic temperature is low, for example, upon start-up of an engine, it has to be rapidly increased for smooth operation of the engine. Accordingly the exhaust emission catalyst is provided at a

position in the exhaust system where the exhaust gas at high temperature (with high thermal energy) passes, for example, in the vicinity of an exhaust manifold and the like. Then an exhaust heat power generation apparatus is provided downstream of the exhaust emission catalyst in the exhaust system, for example, at a position near a sub-muffler. The temperature of the exhaust gas passing at the position downstream of the exhaust catalyst, however, becomes low because it has been used for increasing the catalytic temperature or it has been dispersed as it flows, resulting in decrease in the thermal energy. As a result, the thermoelectric conversion efficiency of the exhaust heat power generation apparatus is decreased, failing to effectively collect the thermal energy.

Under a high load of the engine (at a high engine speed), the exhaust emission catalytic temperature becomes considerably high as it is heated by the exhaust gas at high temperature in the vicinity of the exhaust manifold. When the catalytic temperature exceeds the activated temperature, its purification effect is deteriorated, which may thermally degrade the catalyst. Conventionally in the exhaust system, when the catalytic temperature exceeds the activated temperature, the engine is operated in a fuel-rich state so as to decrease the catalytic temperature. This may increase the fuel supply quantity, resulting in deteriorated fuel efficiency.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an exhaust system that prevents degradation of the catalyst while improving the fuel efficiency.

The exhaust system according to one aspect of the invention includes a primary exhaust emission control unit for purifying the exhaust gas and a first exhaust heat collecting unit for collecting the thermal energy through conversion thereof into electric energy. The exhaust system includes a second passage through which the exhaust gas flows without passing through the primary exhaust emission control unit in addition to the first passage that allows the exhaust gas to flow therethrough. The exhaust system includes the primary exhaust emission control unit within the first passage so as to purify the exhaust gas flowing therethrough. The exhaust system includes a control member that serves to change a flow of gas between the first passage and the second passage. In the case where the catalytic temperature becomes high, the exhaust gas is controlled to flow through the second passage in the exhaust system so as to avoid excessive increase in the catalytic temperature owing to the exhaust gas at high temperature. This makes it possible to prevent thermal

WHAT IS CLAIMED IS:

1. An exhaust system comprising:

an exhaust passage that allows exhaust gas discharged from an internal combustion engine to pass therethrough;

a primary exhaust emission control unit including a catalyst to purify the exhaust gas; and

a first exhaust heat collecting unit including a thermoelectric element that converts thermal energy of the exhaust gas into electric energy; wherein:

the exhaust passage is divided into a first passage provided with the primary exhaust emission control unit and a second passage provided with the first exhaust heat collecting device including the thermoelectric element, the exhaust system further comprising a control member that is operated to change a flow of the exhaust gas between the first passage and the second passage.

2. The exhaust system according to claim 1, further comprising a secondary exhaust emission control unit provided on the exhaust passage where the first passage and the second passage are joined.

3. The exhaust system according to claim 2 or 3, wherein an operation of the control member is controlled based on at least one of a temperature in the primary exhaust emission control unit and a temperature in the secondary exhaust emission control unit.

4. The exhaust system according to claim 3, wherein the control member is operated such that the exhaust gas flows through the second passage when the one of the temperature in the primary exhaust emission control unit and the temperature in the secondary exhaust emission control unit exceeds a predetermined temperature.

5. The exhaust system according to claim 4, wherein the predetermined temperature is determined based on an activated temperature of the catalyst in one of the primary exhaust emission control unit and the secondary exhaust emission control unit.

6. The exhaust system according to claim 2, further comprising a second exhaust heat collecting unit including a thermoelectric element downstream of the secondary exhaust emission control unit.

7. The exhaust system according to claim 1 or 2, wherein:

the first passage and the second passage are combined into a single structure;

the first passage is provided in a center of the structure; and

the second passage is provided on an outer periphery of the first passage.

8. The exhaust system according to claim 1 or 2, wherein:

the second passage includes a heat exchange member that transfers heat of the exhaust gas to the exhaust heat collecting device; and

the exhaust heat collecting device is provided with a catalyst for purifying the exhaust gas.

9. The exhaust system according to claim 8, wherein the catalyst is carried on the heat exchange member.

10. The exhaust system according to claim 7, wherein the structure in which the first passage and the second passage are combined is placed in the vicinity of an exhaust manifold in the internal combustion engine.

11. The exhaust system according to any one of claims 1 to 4, wherein the control member serves to change each flow rate of the exhaust gas flowing into the first passage and the second passage.

12. The exhaust system according to claim 16, wherein the control member comprises a valve that is operated to close and open one of the first passage and the second passage at a predetermined degree.